

## REMARKS

Favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

Claim 18 has been rewritten into independent form to incorporate the subject matter of claim 1 as well as claim 4.

Claims 1-17 and 19-23 are cancelled without prejudice.

New claims 24-34 are added corresponding to former claims 3, 5-8 and 10-15, respectively.

The prior art fails to disclose or suggest the process for producing a separator for a solid polymer-type fuel cell according to the amended and new claims.

Turning to the Official Action, claims 1-8, 10-18 and 21-23 are rejected under 35 USC 102 as anticipated by or, in the alternative, under 35 USC 103 as obvious over Butler.

Claims 1-7, 10-11, 13, 16-18 and 21-23 are rejected under 35 USC 102 as anticipated by or, in the alternative, under 35 USC 103 as obvious over Wilson.

Claims 1-8, 10-18 and 21-23 are also rejected under 35 USC 103 as unpatentable over Butler in view of Saito et al.

These grounds of rejection are respectfully traversed as applied to the claims after the foregoing amendments.

### BUTLER REFERENCE

(1) Butler discloses "A composition comprising

- a) an unsaturated prepolymer resin which comprises one or more of unsaturated polyester and vinyl ester resin;
- b) an unsaturated material copolymerizable with said resin and including a terminal ethylene group;
- c) at least 50% by total weight of the composition comprising a conductive filler;
- d) an initiator to initiate said copolymerization; and
- e) an effective amount of a rheological modifier to prevent phase separation between said resin and said conductive filler during molding, said rheological modifier being one or more compositions selected from the group consisting of Group II oxides and hydroxides,

carbodiimides, aziridines, polyisocyanates, polytetrafluorethylene, perfluoropolyether, polyethylene and fumed silica, and clays” (claim 1).

Regarding conductive fillers, Butler describes “A preferred filler is graphite particles” (column 4, lines 41-42). “Desirably conductive fillers are at least about 50, about 60, or about 65 weight percent of the molding composition. More desirably the filler is more than about 70 or 71 percent to about 78 weight percent of the molding composition” (column 4, lines 56-60). Further, with regard to an unsaturated prepolymer, “vinyl ester resins are the reaction product of an epoxy terminated oligomer, for example, an epoxy functionalized bisphenol A with an acrylic acid, or methacrylic acid forming acrylic terminal groups on the oligomer” (column 4, lines 18-21). Regarding the copolymerizable unsaturated monomer, “this component is capable of dissolving the resin component at room temperature. ... Examples of suitable monomers are styrene ... The ratio of monomer(s) to resin is desirably from about 40:60 to about 75:25 and preferably from about 40:60 to about 65:35 by weight” (column 4, lines 27-37). Regarding a low-profile agent, “Other optional components to a molding composition include ... low shrinkage additives like polyvinyl acetate or polyethylene” (column 6, lines 38-41).

Furthermore, regarding the molding method, “The molding compositions may be formulated and mixed using a variety of mixing conditions including either continuous or batch and using a variety of known mixing equipment” (column 6, lines 61-64).

Regarding advantages of Butler, there describes “Molded products made from the compositions of the present invention are useful for a variety of applications demanding complex configurations, conductivity, as well as strength, and corrosion resistance. One particularly advantageous product which can be made by compression molding is a bipolar plate for use in fuel cells” (column 7, lines 19-23).

#### WILSON REFERENCE

(2) Wilson discloses “A bipolar plate for use in an electrochemical cell comprising an electrically conductive plate formed from a thermosetting vinyl ester resin having a conductive powder embedded therein in an amount effective to provide a electrical conductivity of at least about 10 S/cm for said bipolar plate” (claim 1).

Regarding the vinyl ester-series resin, Wilson describes “Vinyl esters are methacrylated epoxy difunctional polyesters, and as such are often described as a cross between polyester and epoxy resins” (page 4, lines 23-25). Further, in respect to the amount of the electroconductive particles, “An upper limit on the amount of graphite particles is determined by the need to provide enough resin to maintain plate integrity. This upper limit is about 95% graphite by weight. Thus, depending on the particular fuel cell design, the graphite particle loading should be between 20-95 % by weight” (page 6, lines 10-15). In regard to the agent corresponding to the low-profile agent, “Short polyester or polyacrylonitrile microfibers, commonly referred to as “flock”, could conceivably provide enhanced polymer/resin interfaces and are readily available” (page 6, line 36 to page 7, line 2).

With regard to the production method of the molding, “To prepare the mixture of materials for a bipolar plate, the liquid component is formulated first by combining the catalyst and any other desired additives (such as promoters, accelerants, inhibitors, antifoam agents, fluorochemical intermediates, mold release agents, etc.) with the resin and mixing thoroughly. The pre-blended solids (graphite, fibers, carbon black, etc.) are then mixed into the formulated liquid resin to form a homogeneous compound with a friable, paste-like consistency. For laboratory scale development, mixing can be accomplished with a kitchen-type hand mixer. At both small and large scales, no heat is generated during mixing, so mixer cooling is not required. To form the bipolar plate, the amalgamated resin/graphite/reinforcement mixture is molded into its final shape (which may include flow fields) under heat and pressure” (page 7, line 29 to page 8, line 4).

Regarding advantages of Wilson, there is described “Attributes of a suitable material include: i) high electronic conductivity; ii) low weight; iii) low permeability; iv) physical and chemical stability under fuel cell operating conditions; v) low cost of mass production” (page 1, line 33 to page 2, line 2).

#### SAITO REFERENCE

(3) Saito discloses “A separator for fuel cell, which is a molding comprising a conductive powder and a polymer compound, wherein the conductive carbon powder in the molding has an aspect ratio of 4 to 60, and wherein the molding comprises 100 parts

by weight of the conductive carbon powder and 10 to 60 parts by weight of the polymer compound” (claim 1).

Regarding the polymer, Saito describes “As the polymer compound usable-in the present invention for production of the molding, there can be mentioned one kind or a mixture of two or more kinds, selected from thermosetting resins, thermoplastic resins and rubbers. Of these, the thermosetting resins can be, for example, polycarbodiimide resin, phenolic resin, furfuryl alcohol resin, epoxy resin, cellulose, urea resin, melamine resin, bismaleimidetriazine resin, unsaturated polyester, silicone resin, diallyl phthalate resin, polyaminobismaleimide resin and aromatic polyimide” (column 2, line 65 to column 3, line 7). Further, in regard to the production method of the separator, “In this mixing step, a known industrial mixing method (e.g. twin roll, monoaxial or biaxial extruder, stirring rod, kneader, pressure kneader, ball mill, sample mill, mixer, static mixer, ribbon mixer or Banbury mixer) can be used” (column 3, lines 36-41), and in Examples the resin composition is mixed with the mixer.

Regarding advantages of Saito, there describes “the fuel cell separator of the present invention has high conductivity; therefore, when used in a fuel cell, it can give a fuel cell of high output. Moreover, having high gas impermeability, it can give a fuel cell of high power generation efficiency. Having high strength, the fuel cell separator of the present invention can sufficiently withstand the tightening pressure applied at the time of fuel cell assembling, even when a fuel cell consisting of a large number of cells is assembled. With the separator of the present invention, the fuel cell stack containing electrodes and separators can be tightened strongly; this, together with the high gas impermeability of the present separator, can greatly reduce the gas leakage from the stack; therefore, high power generation efficiency and high safety can be achieved. Further, the present separator is simple to produce and can be produced easily” (column 6, line 66 to column 7, line 15).

#### COMPARISON OF THE PRESENT INVENTION AND THE REFERENCES

(a) The cited references fail to disclose or suggest kneading the specific resin composition with a pressure kneader under the specific pressure according to claim 18 for producing a separator for a solid polymer-type fuel cell.

Specifically, Butler fails to disclose or suggest kneading with a pressure kneader. Incidentally, although the Examiner mentions “Molding and mixing the materials, including pressure kneading and molding, are noted in col.6, line 60 to col. 7”, Butler only describes a pressure in molding (such as compression molding and injection molding) on col.6, line 60 to col. 7. Butler never discloses applying pressure in the kneading step before molding. It is an ordinary practice that the pressure is applied to the kneaded resin composition during molding. It has never been taught in the art to apply pressure during kneading. Further, the Examiner states “It is noted that mixing inherently involves applying pressure to the material and that kneading and mixing are equivalent processes”. The Applicant respectfully disagrees. The pressure applied to a material by mixing is only applied partially to the material by shearing force of the mixer. Such pressure is extremely different from the present pressure applied to the total system containing material by a pressure kneader. Further, Butler fails to teach or suggest kneading with a pressure kneader under a specific pressure of  $9.8 \times 10^3$  to  $9.8 \times 10^5$  Pa higher than atmospheric pressure. The technical meanings of pressurized kneading under the specific pressure is apparent by our previous Declarations (Incidentally, in addition to the Declarations, please see the Declaration filed February 22, 2006).

Wilson teaches that the amalgamated mixture is molded into its final shape under heat and pressure (page 8, lines 2-4 of Wilson). Wilson also fails to disclose or suggest kneading with a pressure kneader, much less under the claimed conditions.

Although Saito discloses the use of various thermosetting resins such as a phenolic resin, an epoxy resin, an unsaturated polyester, a silicone resin and a diallyl phthalate resin, Saito fails to disclose making a fuel cell separator containing a vinyl ester-series resin.

Accordingly, the subject matter of claim 18 is novel and not anticipated by the cited references.

Accordingly, the rejection of the former claims under 35 USC 102 should be withdrawn as applied to the amended and new claims.

Regarding the 103 rejection, Saito discloses a pressure kneader, however the pressure kneader is only exemplified as one example among various known industrial mixing methods. In the Saito Examples, the resin composition is mixed by using a mixer.

That is, in Saito, the mixing is not conducted under any specific pressure. Furthermore, since Saito fails to disclose a vinyl ester-series resin, the combination of a vinyl ester-series resin and pressurized kneading according to the claimed method cannot be suggested over Saito.

Hereinafter, the Applicants would compare a vinyl ester-series resin with an unsaturated polyester-series resin. Among the thermosetting resins of Saito, it seems that the unsaturated polyester-series resin is most similar to the vinyl ester-series resin.

Regarding the comparison, the Applicants submit a Japanese copy and its English translation of a literature (POLYESTER RESIN HAND BOOK, Date of first impression of the first edition : Jun. 30, 1988, Eiichiro Takiyama, THE NIKKAN KOGYO SHIMBUN, LTD., page 375-376) as showing the technical common sense at the present filing date. The literature discloses that the unsaturated polyester-series resin is superior to the vinyl ester-series resin in compatibility with a filler. Accordingly, there was no motivation to use a vinyl ester-series resin with carbon powder from the technical level at the present filing date. Incidentally, regarding “◎, ○, △, X” in the table of the literature, “◎” is the best and “X” is worst.

Additionally, since the compatibility of the vinyl ester-series resin with the filler is low, it seems that a rheological modifier is essential component in the composition of Butler. On the other hand, the technical meanings of using the pressurized kneading without the rheological modifier is apparent from the Rule 132 Declarations of record.

That is, all the references fail to disclose the technical meanings of the pressurized kneading in relation to the vinyl ester-series resin. Therefore, even if the references were combined, the combination of a vinyl ester-series resin and pressurized kneading cannot be predicted over the references. Accordingly, the combination of all elements of the subject matter of claim 18 would never be motivated from the references.

(b) The present invention provides unexpected advantages. That is, since the resin compositions of the references are kneaded by a conventional kneader, as apparent from the previous Declarations, various properties (such as bending strength, thermal conductivity, shrinkage rate and warp) of the mold article would never be improved.

On the other hand, according to the present invention, since the resin composition is kneaded by a pressure kneader, the molded plate formed from the kneaded composition

is wholly homogenous, and thus the various properties of the mold plate can be improved. As the result, properties such as bending strength, thermal conductivity, shrinkage rate and warp of the present mold article (Example 6) are improved.

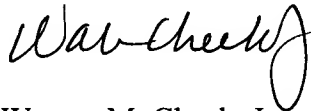
Such advantages of the present invention would never be predicted from the references.

In view of the foregoing, it is respectfully submitted that the claimed process as amended is neither anticipated by nor suggested by the cited prior art.

Favorable reconsideration and allowance is solicited.

Respectfully submitted,

Hiroya OKUMURA et al.

By:   
Warren M. Cheek, Jr.  
Registration No. 33,367  
Attorney for Applicants

WMC/dlk  
Washington, D.C. 20006-1021  
Telephone (202) 721-8200  
Facsimile (202) 721-8250  
May 22, 2006



## 8.7 PHYSICAL PROPERTIES

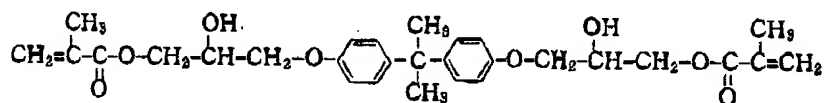
Table 8.10 summarizes differences between vinyl ester resin and other resins having similar structures with the vinyl ester resin in order to evaluate the physical property of the vinyl ester resin.

Table 8.10 (see attachment)

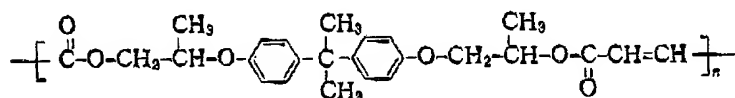
The feature of the vinyl ester resin is, in one word, to have not only physical properties of the epoxy resin but also handleability of the polyester resin.

For reference, the structural formulae of the resins shown in Table 8.10 are described below.

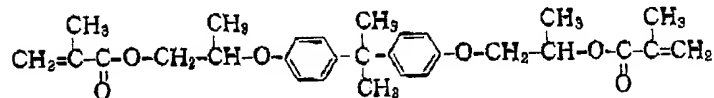
### (1) Vinyl ester resin



### (2) Bisphenol-based polyester resin



### (3) Bisphenol-based polyester-acrylate



### (4) Amine-curing type epoxy resin (room-temperature curing type)

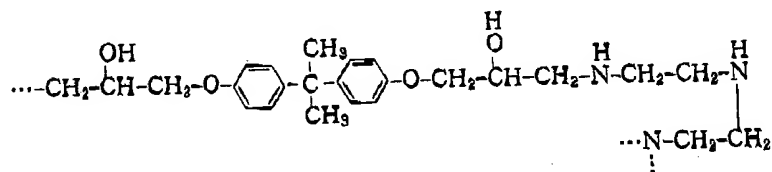




Table 8.10 Comparison in physical properties of resins having similar structures

Properties	Species	Vinyl ester resin	Polyester resin	Epoxy resin (cured with amine)	Polyester-acrylate (type including styrene)
Handleability (Mainly viscosity)		◎	◎	△	◎
Resin odor		Styrenic odor	Styrenic odor	Little or nothing	(The resin itself does not have odor)
Curability		○~◎	◎	△~○	Styrenic odor ○
Skin irritation		(No) ◎	(No) ◎	(Yes) ×	(No) ◎
Hardness		High to low	High to low	High	High
Mechanical property		◎	○	◎	◎
Electric property		◎	◎	◎	◎
Heat deformation temperature (°C)		to 160	to 150	≒100	to 130
Chemical resistance					
Alkali		◎	○	○	◎
Acid (Oxidation)		◎	○	×	◎
Anti-weatherability		○~△	○~△	△	△
Curing shrinkage		○ (5 to 8)	△ (7 to 10)	◎ (3 to 5)	○ (5 to 8)

Table 8.10 Comparison in physical properties between resins having similar structure (continued)

Species	Vinyl ester resin	Polyester resin	Epoxy resin (cured with amine)	Polyester-acrylate (type including styrene)
Properties				
Possibility as a sheet molding compound (SMC)	△~○	◎	×	×
Adhesiveness	○~◎	○	◎	○
Compatibility with filler	○	◎	○	○
Degree of freedom in coloring (color heterogeneity)	△~○	◎	△	△
Degree of freedom in modification	○	◎	△~×	△~×

## 8.7 物 性

ビニルエステル樹脂の物性上の地位がどのようなものであるかを、類似の構造をもった樹脂と比較して表 8.10 に要約した。

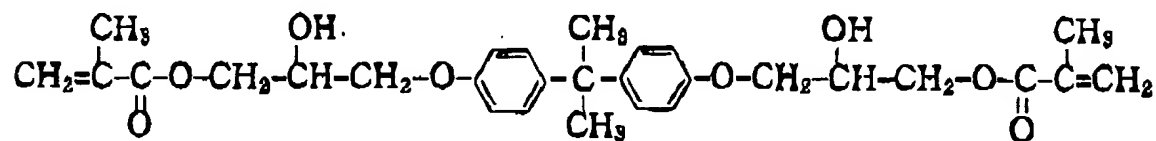
表 8.10 構造類似の樹脂の物性比較

性 質	ビニルエステル樹脂	ポリエステル樹脂	エポキシ樹脂 (アミン硬化)	ポリエステル-アクリレート (含スチレン型)
作業性 (主として粘度)	◎	◎	△	◎
樹脂の臭気	スチレン臭	スチレン臭	ほとんどなし	(樹脂自体はない) スチレン臭
硬化の自在性	○～◎	◎	△～○	○
皮膚刺激性	(無) ◎	(無) ◎	(有) ×	(無) ◎
硬さ	高～低	高～低	高	高
機械的性質	◎	○	◎	◎
電気的性質	◎	◎	◎	◎
熱変形温度 (°C)	～160	～150	≒100	～130
耐薬品性				
アルカリ	◎	○	○	◎
酸 (酸化性)	◎	○	×	◎
耐候性	○～△	○～△	△	△
硬化収縮	○ (6～8)	△ (7～10)	◎ (3～5)	○ (5～8)
成形材料 (SMC) の可能性	△～○	◎	×	×
接着性	○～◎	○	◎	○
フィラー潤和性	○	◎	○	○
着色の自由度 (色むら)	△～○	◎	△	△
変性の自由度	○	◎	△～×	△～×

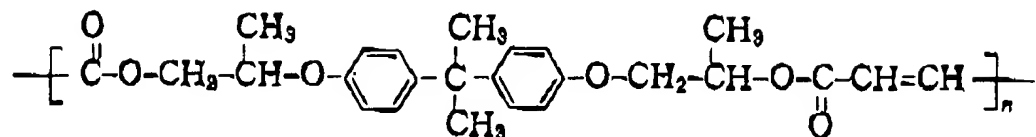
特長を一口でいうならば、エポキシ樹脂の物性とポリエステル樹脂の取扱いやすさを、兼ね備えた、といっても過言ではないであろう。

参考までに、表 8.10 に示した樹脂の構造式を示す。

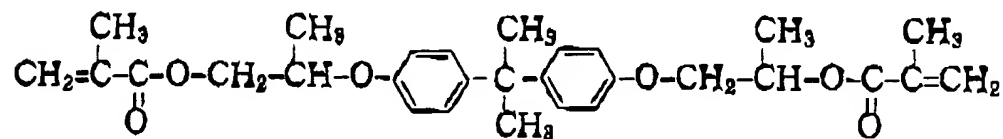
## (1) ビニルエステル樹脂



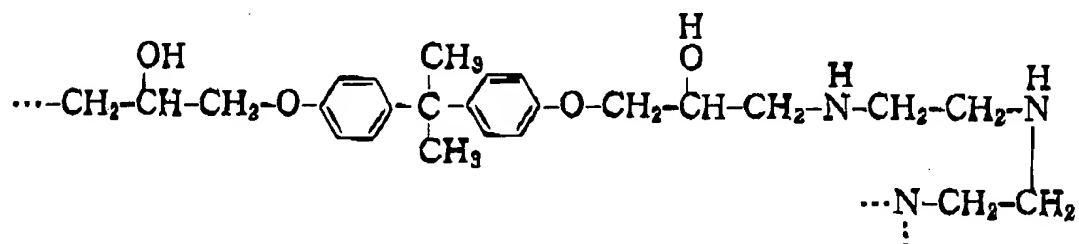
## (2) ビスフェノール型ポリエステル樹脂



## (3) ビスフェノール型ポリエステル-アクリレート



## (4) アミン硬化型エポキシ樹脂 (常温硬化型)



## 8.7.1 硬化樹脂の物性

個々の品種のデータは樹脂メーカーの技術資料に詳しい。  
代表的な構造とその性質を表 8.11 に要約する。

## 8.7.2 耐薬品性

詳細は、樹脂ならびに FRP の物性の項を参照されたい。

ここでは実用的な面から、主な薬液に対する使用の可否を、表 8.12 に示すにとどめる。

## 8.7.3 フレークライニング

耐食ライニングの項を参照されたい。

## 8.7.4 UV キュア

UV キュアの項を参照されたい。

— 著 者 紹 介 —

滝山榮一郎 (たきやま えいいちろう)

昭和 5 年 東京都に生まれる

昭和 28 年 東京工業大学理学部化学科卒

昭和 28 年 理研合成樹脂(株) (現 昭和高分子(株)) 入社

現 在 昭和高分子(株)開発企画部長, 常務理事

主な著書 「プラスチック材料講座 ポリエステル樹脂」

ポリエステル樹脂ハンドブック

NDC 578

昭和 69 年 6 月 30 日 初版 1 刷発行

(定価はケースに表  
示してあります)

◎ 著 者 滝 山 榮 一 郎

発行者 藤 吉 敏 生

発行所 日刊工業新聞社

東京都千代田区九段北1-8-10

(郵便番号 102)

電話 東京 (263) 2311 (大代表)

振替口座 東京 9-186076

印刷所 (株) コ ー ラ ル

製本所 宮 入 製 本 所

落丁・乱丁本はお取り替え致します。

ISBN4-526-02365-5 C3058